REMARKS

The Examiner's Action mailed on May 14, 2008, has been received and its contents carefully considered.

In this Amendment, Applicants have amended claim 1, canceled claims 2-4, and added claims 10 and 11. Claim 1 is the independent claim, and claims 1 and 5-11 are pending in the application. For at least the following reasons, it is submitted that this application is in condition for allowance.

The Examiner's Action has objected to claim 4. Because claim 4 has been canceled, this objection has been rendered moot. Moreover, amended claim 1 that incorporates the subject matter of claim 4 recites "the balance" as suggested by the Examiner, rather than "the residual," so as to ensure that this claim complies with all official provisions.

The Examiner's Action has rejected claims 1-5 as being obvious over *Yoshida et al.* (USP 6,319,337) (hereafter simply *Yoshida*) in view of *Hassell et al.* ("Induction Heat Treating of Steel," Vol. 4, ASM Handbooks Online) (hereafter simply *Hassell*). The Examiner's Action has further rejected claim 3 as being obvious over *Yoshida* in view of *Hassell*, and further in view of *Watari et al.*(USP 6,475,305). Because claims 2-4 have been canceled, the rejections pertaining thereto have been rendered moot. Further, because claim 1 has been amended to incorporate the subject matter of claims 2-4, Applicants will treat the rejection of claims 2-4 as pertaining to amended claim 1. It is submitted that claims 1 and 5

are patentably distinguishable over the cited references for at least the following reasons.

Claim 1 is directed to a pinion shaft formed using a non-refine steel as a material, which includes a shaft section and a pinion teeth forming section. This claim recites that surface hardness of the pinion teeth forming section and the shaft section is 650 to 760 HV in terms of Vickers hardness. Claim 1 further recites that the steel contains C, Si, Mn, Mo, Cu, Ni, and Cr, and satisfies Equation 1 (i.e., $0.80 \leqq Ceq \leqq 0.95$, where $Ceq = a(C) + 0.07 \times a(Si) + 0.16 \times a(Mn) + 0.20 \times a(Cr) + 0.72 \times a(Mo)$) and Equation 2 (i.e., f value $\leqq 1.0$, where f value $= 2.78 - 3.2 \times a(C) + 0.05 \times a(Si) - 0.60 \times a(Mn) - 0.55 \times a(Cu) - 0.80 \times a(Ni) - 0.75 \times a(Cr)$), with the contents (% by mass) of C, Si, Mn, Mo, Cu, Ni, and Cr being respectively represented by a(C), a(Si), a(Mn), a(Mo), a(Cu), a(Ni), and a(Cr), and further recites that the balance of the steel is composed of Fe and incidental impurities. This claimed invention is not disclosed or suggested by the cited references.

Yoshida is directed to a power transmission shaft. However, as acknowledged by the Examiner, *Yoshida* does not disclose or suggest that surface hardness is 650 to 760 HV, as recited in claim 1.

The Examiner further relies on *Hassell*, asserting that producing a shaft and gear of *Yoshida* with a desired hardness such as 650-760 HV as claimed would merely involve **routine experimentation** for one of ordinary skill in the art, as

taught by *Hassell*. This assertion is respectfully traversed for the following reasons.

MPEP §2144.05 states that where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by **routine experimentation**, see *In re Aller*, 105 USPQ 233, 235 (CCPA 1955) (claimed process which was performed at a temperature between 40°C and 80°C and an acid concentration between 25% and 70% was held to be *prima facie* obvious over **a reference process** which differed from the claims only in that the reference process was performed at a **temperature** of 100°C and an **acid concentration** of 10%); see also *Peterson*, 65 USPQ2d at 1382 ("The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a **disclosed set of percentage ranges** is the optimum combination of percentages.").

Further, in *In re Fay*, 347 F.2d 597 (C.C.P.A., 1965), it is held that the one skilled in the art must be so guided and directed as to eliminate the areas of speculation. It is further held that a primary determination should be made of whether or not Applicants' experimentation comes **within the teaching of the art**. If this primary determination is not met, whether the subsequent experimentation is termed "routine" or not is of no consequence. For example, in *In re Aller*, the prior art provided a temperature range and an acid concentration that were optimized by the claimed process, and in *Peterson*, the set of percentage ranges

were already disclosed in the prior art.

However, neither *Yoshida* nor *Hassell* provide any range of surface hardness. As noted above, *Yoshida* is silent as to the surface hardness. Further, *Hassell* simply states, "the ability to limit the heated surface area and the depth makes induction heating particularly attractive. Localized hardening increases the metal's outer layer strength and bestows favorable residual compressive stresses. Selective treatment also saves time and energy and will minimize distortion" (see page 3), "gear teeth and roots can be selectively hardened, ... and uniform hardening of all contact area results in high wear resistance" (see page 17). Thus, *Hassell* does not disclose or suggest any range of surface hardness of the gear teeth and roots, which would be required to meet the obviousness rejection based on the **routine experimentation** test. Accordingly, the claimed range of surface hardness of the pinion teeth section and the shaft section is not disclosed or suggested by the cited references.

Claim 1 further recites that the steel contains C, Si, Mn, Mo, Cu, Ni, and Cr, and satisfies Equation 1 (i.e., $0.80 \leqq Ceq \leqq 0.95$, where $Ceq = a(C) + 0.07 \times a(Si) + 0.16 \times a(Mn) + 0.20 \times a(Cr) + 0.72 \times a(Mo)$) and Equation 2 (i.e., f value $\leqq 1.0$, where f value $= 2.78 - 3.2 \times a(C) + 0.05 \times a(Si) - 0.60 \times a(Mn) - 0.55 \times a(Cu) - 0.80 \times a(Ni) - 0.75 \times a(Cr)$), and the balance of the steel is composed of Fe and incidental impurities. The Examiner asserts that such equations would not result in a patentable difference because it has been held that there is no invention

involved in the discovery of a general formula if it covers a composition described in the prior art.

However, MPEP §2144.05 III states that Applicant can rebut a presumption of obviousness based on a claimed invention that falls within a prior art range by showing that there are **new and unexpected results** relative to the prior art.

The specification, at page 20, line 23, through, page 23, line 8, describes as follows:

> It is desirable that in order to ensure the tool life in machining of the pinion shaft and the strength of the pinion shaft, the hardness in an inclusion for production after hot rolling for forming the pinion shaft is *24 to 30 HRC*. The reason for this is that strength required for the pinion shaft is not obtained when the hardness is less than 24 HRC, while the tool life is reduced to increase the cost, requiring a time period for machining when the hardness exceeds 30 HRC.
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> ... *The hardness* of the steel after hot rolling almost *depends on the magnitude of Ceq*. In order that the hardness may be 24 to 30 HRC, described above, *Ceq must be 0.80 to 0.95*. The reason for this is that the hardness after hot rolling does not become not less than 24 HRC *when Ceq is less than 0.80*, while it is higher than 30 HRC, making the steel too hard, deteriorating the machinability, and thereby deteriorating tooth form accuracy *when Ceq is more than 0.95*.
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> Similarly, in the case of the steel for a pinion shaft, the ferrite amount therein almost *depends on the magnitude of the f value*. In order that the ferrite amount may be a ferrite area ratio of not more than 40 % required as the steel for a pinion shaft, the *f value must be set to not more than 1.0*.
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> When a large amount of ferrite exists in a tissue before high frequency quenching, C is not sufficiently diffused into the ferrite in heat treatment for a short time, for example, high frequency quenching, and the ferrite remains in the tissue after high frequency quenching. The residual ferrite causes the bending and torsional strength to be reduced. Further, uniform hardness is not easily obtained, and the wear resistance is also deteriorated.
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> ... It is desirable that *the ferrite amount* before high frequency quenching is *not more than 40 %*. For that purpose, *the f value* is set to not more than 1.0.

Accordingly, the claimed Equations 1 and 2 specify relationships between the amount of C, Si, Mn, Mo, Cu, Ni, and Cr, thereby providing new and unexpected results. That is, the amount of C, Si, Mn, Mo, Cu, Ni, and Cr *that satisfies the claimed Equations 1 and 2* makes it possible to regulate the hardness in an inclusion for production after hot rolling for forming the pinion shaft to be 24 to 30 HRC, as well as to regulate the ferrite amount to be not more than 40 %, which are not disclosed or suggested by the cited references.

For example, as shown in Tables 1 and 2 of the specification, the Comparative Example 1 illustrates that Ceq value is 0.78 (which is not within the claimed range, i.e., $0.80 \leqq Ceq \leqq 0.95$), even when the individual elements (C, Si, Mn, Mo, Cu, Ni, and Cr) are respectively within the claimed range. Thus, the hardness in the inclusion and the ferrite amount are regulated by the claimed Ceq value and f value that satisfy the Equations 1 and 2, rather than by respective amount range of C, Si, Mn, Mo, Cu, Ni, and Cr.

Accordingly, independent claim 1, and claim 5 that depends therefrom, are *prima facie* patentably distinguishable over the cited references.

The Examiner has further rejected claims 6-9 as being obvious over *Yoshida* in view of *Hassell*, and further in view of *Iguchi et al.* (USP 6,270,596) (hereafter simply *Iguchi*). However, because *Iguchi* does not overcome the above-noted deficiencies of *Yoshida* and *Hassell*, and because claims 6-9 depend from

claim 1, these claims are *prima facie* patentably distinguishable over the cited references for at least the same reasons as claim 1.

In addition, claims 6 and 7 further recite that a ratio D/R is in a range of 0.1 to 0.5 (claim 6) or 0.1 to 0.4 (claim 7). As described in the specification, at page 25, lines 4-6, when the ratio D/R exceeds 0.5, the strain of the pinion teeth is increased. In contrast, *Iguchi* simply describes that when the ratio (distance from the surface to a position of 500 HV/radius of component) is less than 0.25, the fracture occurs. Thus, the claimed upper limit of the ratio D/R provides new results that are not expected by the lower limit disclosed by *Iguchi.*

Claims 8 and 9 further recite that a ratio d/r is in a range of 0.05 to 0.6 (claim 8) or 0.35 to 0.5 (claim 9). As described in the specification, at page 26, lines 3-6, when the ratio d/r exceeds 0.6, the toughness is deteriorated, and the manufacturing cost is high. In contrast, *Iguchi* simply describes the lower limit of the ratio for preventing the fracture. The prevention of deterioration of the toughness is a new result obtained by the claimed ratio and can not be expected by the ratio of *Iguchi* that only prevents the fracture.

New claims 10 and 11 have been added. Because claims 10 and 11 depend from claim 1, these claims are *prima facie* patentably distinguishable over the cited references for at least the same reasons as claim 1.

In addition, claim 10 recites that the ratio D/R is in a range of 0.1 to 0.24, and claim 11 recites that the ratio d/r is in a range of 0.05 to 0.24. In contrast, as noted above, *Iguchi* requires that the ratio be not less than 0.25, because when

the ratio is less than 0.25, the fracture occurs (see *Iguchi*, Abstract). Thus, *Iguchi* teaches away from having a ratio less than 0.25, as recited in claims 10 and 11.

It is submitted that this application is in condition for allowance. Such action and the passing of this case to issue are requested.

Should the Examiner feel that a conference would help to expedite the prosecution of this application, the Examiner is hereby invited to contact the undersigned counsel to arrange for such an interview.

Should any fees be required, however, the Commissioner is hereby authorized to charge the fees to our Deposit Account No. 18-0002, and is requested to advise us accordingly.

Respectfully submitted,

August 8, 2008
Date

Robert H. Berdo, Jr. – Reg. No. 38,075
RABIN & BERDO, PC – Cust. No. 23995
Telephone: 202-371-8976
Fax: 202-408-0924

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